Final Technical Report

"Study of Variable Extinction of Hot Stars with Circumstellar Dust Shells"

NAG 5-190

The grant NAG 5-190 began funding a study of hot stars with dust shells using the International Ultraviolet Explorer satellite (IUE). Later IUE research was done through NASA funding on other research areas (besides hot stars with dust) using the same grant number even though the title name was inappropriate.

During the period of funding for this grant a number of projects were completed on the topic of hot stars with circumstellar dust.

The first complete ultraviolet/visual/infrared study of the variable WC7 star HD 193793 was made by Fitzpatrick, Savage, and Sitko (1982). The data allowed us to determine a number of important parameters for this star including its surface temperature (43000 K), terminal wind speed (3000 km s^{-1}), and interstellar reddening (E(B-V) = 0.85 mag). HD 193793 is only one of two WC7 stars known to produce circumstellar dust grains.

The first detection of circumstellar CO molecules around a hot star was made by Sitko (1983) for the star HD 44179, the central object in the Red Rectangle nebula. The possible presence of more complex hydrocarbon molecules was also possible. With $N_{CO} \sim 10^{18}$ cm^{-2} and large amounts of (presumably) carbonaceous dust, this object must have C/O $>$ 1 and be a highly evolved post-main sequence star. The large extinction at $\lambda < 1600$ Å is of unknown origin but may result from CO_2 produced by the catalytic conversion of CO to carbon-chain molecules.

Sitko, Simon, and Meade (1984) have recently published a study of the circumstellar dust shell surrounding the star W90 in the young cluster NGC2264. They find that the extinction by the dust around this star is very wavelength-independent, unlike "normal" interstellar dust. They also find that the ultraviolet flux deficiency greatly exceeds all of the known re-radiation in the infrared, suggesting a non-spherical geometry for its dust envelope. Observations on two other stars in the cluster (W46, W100) yielded null results.

Savage and Sitko (1984) have rebutted a suggestion that a newly-discovered extinction feature at 2800 Å is real and due to complex molecules. They show that this was an instrumental artifact of the IUE data that was not properly accounted for in these other investigator's work.

Further work on dust shells is continuing. An IUE proposal to re-examine the earlier study by Sitko, Savage, and Meade (1981) and Sitko (1981) is planned.

The remaining work with NAG 5-190 dealt with spectral properties of various active extragalactic objects. Spectra of low-redshift and X-ray emitting quasars by Sitko and Stein is continuing. This has led to the definition of a very promising project now underway at Kitt Peak National Observatory with simultaneous observations with the IUE. Similar observations by other groups has led to important estimates of source sizes and masses for the Seyfert 1 galaxy NGC 4151 and the quasar PG 1351+64. Continued funding for this new program is expected to continue at Kitt Peak (Sitko's new residence) using funds awarded but not yet received from NASA as part of the 1984 IUE observing program XQGMS.

Another study, on strong extragalactic 1-mm sources, was funded through NAG 1-590 during the 1983 IUE episode. These data have been combined with simultaneous visual, infrared, millimeter, and centimeter data and have been analyzed at Minnesota. Theoretical modeling is nearing completion and a paper is expected to be written soon.

Some of these IUE data have already been referenced in print (Sitko, Stein, and Schmidt 1984; Rudnick, Sitko, and Stein 1984). Completion is expected soon.

References

* Fitzpatrick, E.L., Savage, B.D., and Sitko, M.L., 1982, Ap.J., 256, 578.

+ Rudnick, L., Sitko, M.L., and Stein, W.A., A.J., 89, 753.

* Savage, B.D. and Sitko, M.L., 1984, Ap. Sp. Sci., 100, 427.

Sitko, M.L., 1981, Ap.J., 247, 1024.

* Sitko, M.L., 1983, Ap.J., 256, 848.

Sitko, M.L., Savage, B.D., and Meade, M.R., 1981, Ap.J., 246, 161.

* Sitko, M.L., Simon, T., and Meade, M.R., 1984, Pub.A.S.P., 96, 54.

+ Sitko, M.L., Stein, W.A., and Schmidt, G.D., 1984, Ap.J., 282, 29.

* = Publications supported by NAG 5-190.

+ = Publications making limited use of some of the IUE data, but not yet fully published.